Research Paper | Agricultural | E-ISSN No : 2454-9916 | Volume : 4 | Issue : 2 | Feb 2018

S.M.A.R.T. SOLUTION FOR DROUGHT PREDICTION AND MANAGEMENT

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ABSTRACT

Artificial Intelligence is the branch of technology that has been used for developing prediction models for various environmental crisis but it is still in the inception phase for predicting natural disasters in general and droughts in specific .India has gross irrigated area of 82.6 million hectares which is largest in the world but due to global warming and other climatic changes the weather cycle has been changing and there is a increase in cases of continuous droughts in particular regions, therefore there is need of statistically analyzing and predicting droughts. The integration of various technologies like A.I., HMM, GIS, Remote sensing and DSS can be used for development of advance forecasting systems, so that the intensity of drought can be reduced with timely support given to the particular area and farmers. This paper proposes a new model whose development will boost growth of Indian agriculture and will give new meaning to the digital India concept in true sense.

KEYWORDS: Simple Manageable Agriculture Research Technology(S.M.A.R.T),Artificial intelligence, ANN in agriculture, Hidden Markov Models.

1. INTRODUCTION:

In India more than 70% of the population is directly dependent on agriculture and related farming work for their livelihood. About 16% of India's total area is drought-prone and about 50 million people are annually affected by drought. The drought-prone areas of the country are mainly confined to western and peninsular India—mainly arid, semi-arid, and sub humid regions. The arid tract of western part of India is under threat of severe droughts due to paucity, abnormality of rainfall and severe climatic Characteristics [1];[2]. The climatic changes due to global warming has changed the weather cycle and there has been increase in the occurrences of the natural disasters like landslides, tsunamis, flood and droughts in some regions. Even with most advance technologies it is nearly impossible to control these disasters but a forecasting technique can be developed so that the loss can be minimized and precious human lives can be saved. The technological advances are visible in every sector but not the agricultural sector which is the main part of Indian economy. In this paper we have tried to propose a S.M.A.R.T model for agricultural drought forecasting by integrating the three foremost technologies i.e. A.I., G.I.S.& RS. S.M.A.R.T. stands for Simple Manageable Agriculture Research Technology. The purpose of this smart model is to give the farmers intimation about the climatic changes and give suggestion on the crop changes with suitable soil types so that they don't incur total loss of crops and commit suicide. Our focus is on the integration of four technologies as shown in the Fig. 1. below. Ghosh et al (2009) in his study on trend analysis of Indian Summer Monsoon Rainfall (ISMR) at different spatial scales found that the conventional method of representing ISMR using a single variable has some limitations and may result in an erroneous outcome for a few places. The results of local-scale studies may not match with those of large-scale analysis. India, being a developing country, is characterized by local-scale changes, viz., population, growth and urbanization, which have significant impacts on the summer monsoon rainfall pattern. These local changes are obviously not uniform all over India. Therefore, results at a finer scale considering spatial variability are more important and reliable for further use of rainfall data in hydrological applications, water resources management and agricultural water management.

In general, drought is determined by comparing the departures and excess amount with the average rainfall over several years. The drought index is useful in identifying the occurrence, extent and severity of drought. Many researchers have used several weather and weather related parameters for predicting the onset of Monsoon. Different types of models like multiple regression models, Autoregressive Integrated Moving Average method (ARIMA), power (nonlinear) regression models and neural models are used for generating predictions. The official forecast of the IMD is based on the 16 parameter power regression models. Many researchers used Time series methods, Casual methods and Judgmental method for forecasting of rainfall. Autoregressive Moving Average (ARMA), Exponential Smoothing, Extrapolation, Linear Prediction, Trend Estimation, Growth Curve and Box-Jenkins Approach are the methods of Time series modeling which require long term data [3], [4]; [5], [6], [7] [8]; [9]; [10], [11]; [12].Soft computing technologies are the growing technologies for long term rainfall prediction which uses several Fuzzy, regression and neural network based models[13].

The sole objective of the proposed model is to benefit the farmer with decision making and reduce the risk of crop loss. We can say it provides a mitigation plan for farmers whether literate or illiterate. The paper is organized with the study with understanding the concept , it's background and then we have explained the model with it's working and example.

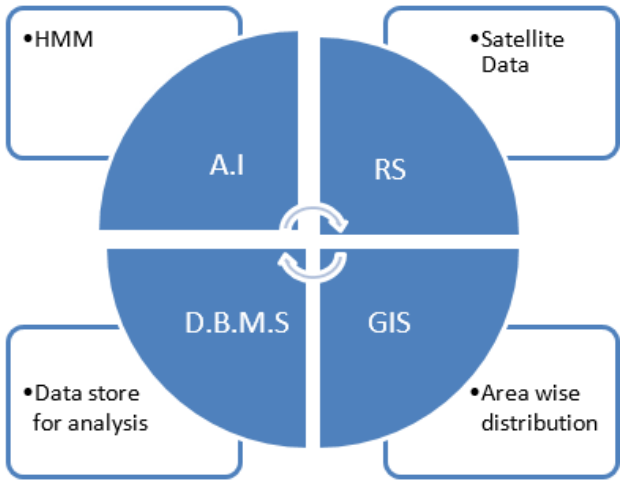

Fig 1: Integration of technologies for S.M.A.R.T model.

2. CONCEPT:

We know that the droughts are basically classified in to three types i.e. Hydrological, Meteorological and Agricultural and India is affected by all three of them at some time of the year. If the farmer is given real time analysis of soil condition, weather situation in near future depending upon the analysis of past conditions then the farmer can plan the crops throughout the year. It can be mitigation action that can reduce the damage caused by droughts.

In our paper we have tried to approach the problem of drought and its management with a new concept i.e. directly making the implementation of the farmers field through Remote sensing, giving the real time information of whether the field is suitable for certain crop or not and how much yield can be expected with the current field situation, moreover remedial approach for the changing situation can be provided so that the farmer could take timely decision. Our idea is to do SMART farming instead of waiting for the weather to respond to the needs of the farmer. We know that India being a large country with total of 3.287 million km^2, 29 states and 7 Union territories and the 159.7 million hectares of overall farming area, which is second largest in the world after United States. We have to deal with very large quantity of data, but we need to do disaster mitigation since due to natural disasters like droughts and flood there is rise in loss of human lives as well as low quality crops.

3. BACKGROUND:

Natural disasters are very tough to handle as they are unpredicted and the loss ensued is much greater so much so that sometimes it creates a major gap in country's economic growth. The repetition of these disasters cannot be stopped but a strategy for reducing their effects can be ensured basically Disaster management involves four main components given in fig 2 below.

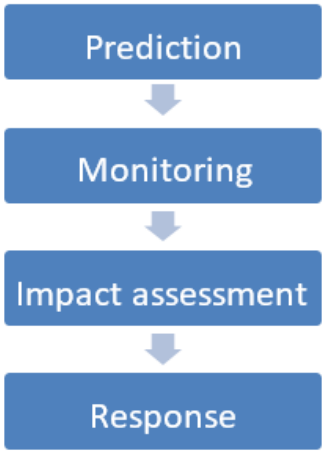

Fig. 2: Components of Disaster Management.

Prediction involves studying of climatic conditions, Monitoring can be further classified in a) Ground based information and b) satellite observation it involves study of soil moisture, crop types etc , Impact assessment is carried out on basis of land use type , stressed condition, involves the total loss incurred, Response involves action taken by the farmer like crop rotation , local planning , water conservation and other practices .

With the study of various research articles we have found that there are various expert systems for different crops like Wheat Pakistani Expert System by Khan et al (2008)[14]. Mango expert system by Prasad et al (2006)[15]. Rice Expert System by Sarma et al (2010)[16]. POMEE is an Expert system for apple orchid management, A.J. Castro and Garcia et.al. (1995) explains an expert system SEMAGI has been developed for sunflower[17;24], and so many others though they provide significant level of information and give consistent answers for repetitive decisions, processes and tasks[18;21] but it does not take in to consideration that most farmers are illiterate , the images used in these systems are not real time therefore the analysis cannot be done properly, moreover Expert Systems are not compact as a neural network and genetic algorithm systems .This makes them harder to embed in other systems, as the inference engine and working memory must be part of the system at run time[22][23].

In our model we propose to use HMM algorithm and create data store corresponding to various regions of India for that purpose we classified India in four zones of East, West, North, South and major crops and soil types of these four zones through which crop growth parameters, condition of the yield and total yield can be predicted. We also propose to use image analysis of the field of farmer with the help of existing GPRS technology and Remote sensing of the field by obtaining images of the field .This way the current condition of the field can be analyzed and proper prediction can be done.

4. S.M.A.R.T MODEL:

The inception of idea came from the fact that Bhuvan portal provides dataset of every area and also give update about the current condition of the area, therefore for our model we decided to link the country and managing the data of various subdivisions.

Working of the proposed model:

The working of the model is explained in the steps below.

- Step1: The farmer puts a query in his own native language[voice/ text] and tell about the zone he belongs to , the area of land and the crop he want to sow during the weather cycle of the year.
- Step 2: Through GIS the location of the field can be tracked and through satellite observation the current condition of the field can be evaluated.
- Step3: The weather forecasting model can predict the upcoming conditions for that particular crop in the area and the expected yield for the crop.
- Step4: Summarizing the data the farmer can be reported in his own language [voice/text] about the analysis and then he can take the decision in favor or can reject the decision.

For example consider a situation where a farmer from Maharashtra wants to sow cotton in the month of June-July i.e. after the official Monsoon arrival. He can put a query describing the area of land, the zone and how much yield he can expect from the current weather conditions and the remedial measures if any to be taken for better yield. The query will be analyzed by the proposed system with past records of the particular area where the farmer's land is located, the amount of rainfall expected in the current monsoon cycle for that area, By RS the field analysis of that particular land can be observed and the response can be generated based on these parameters. The remedial procedure to be followed in case of Drought conditions can also be listed and given to the farmer by either text or voice method.

The pictorial representation for better understanding of the model is shown in Fig.3. below for reference.

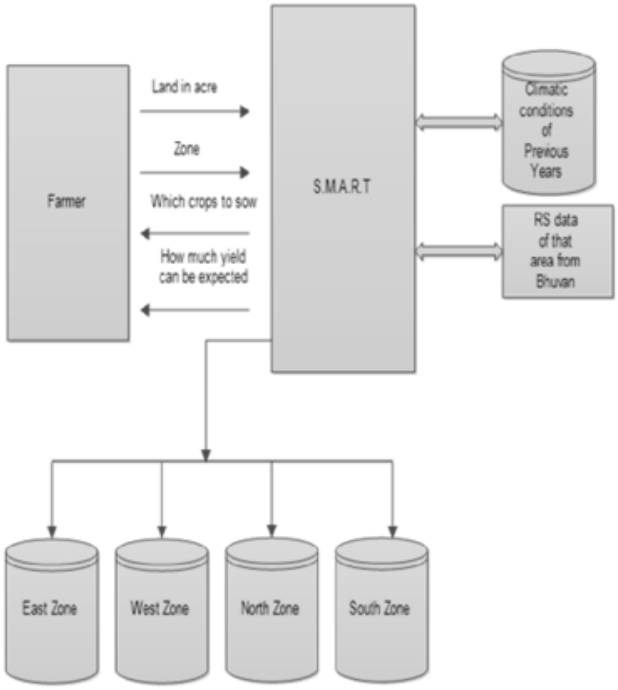

Fig .3: S.M.A.R.T MODEL

5. CONCLUSION:

The proposed model is dealing with the large amount of data and its analysis, though it is still a proposal it deals with the technology integration at very large scale. It will make agriculture decision making more approachable though data collection is a tedious work once this is done the result will be far reaching. The work of this model is in inception phase. We have planned to design the model just for one particular zone, as it is observed that there are various departments working towards the common goals the only thing needed is linking or integrating them. Suggestion and Improvements are recommended through expert guidance.

Though this is a very farfetched idea its implementation will change the picture of Indian farmers.

6. ACKNOWLEDGEMENT:

We would like to sincerely thank our college authorities & special thanks to Secretary Satish Chavan & Principal Dr. B. S. Jadhav for giving us the creative freedom and giving us the required facilities to conduct the research needed for this concept. Our sincere gratitude to Dr. S. C. Mehrotra sir for giving us his time and guiding us on how to present a concept and penning it down.

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